Subject programme

1. Subject name / subject module: **Elective Subject: Data transmission**
2. Lecture language: **English**
3. The location of the subject in study plans:
    - Area or areas of the studies: **Computer Control Systems Engineering**
    - Degree of the studies: **2nd degree studies**
    - Field or fields (implementation of effects standard): **Mechatronics**
4. Supervision of subject implementation:
    - The Institute / Another unit: **Institute of Informatics and Mechatronics**
    - The person responsible for the subject: **Buler Piotr, mgr**
    - People cooperating in the development of the programme of the subject:
5. The number of hours and forms of teaching for individual study system and the evaluation method:

| Mode of study | Teaching activities with the tutor | | | | | | | | | | | | Total |
| | Form of classes | | | | | | | | | | | | |
	…	SOW	ECTS	Laboratory work	SOW	ECTS	…	SOW	ECTS	…	SOW	ECTS	ECTS
Full-time studies				45	55	4							4
Part-time studies													
Credit rigor			Graded assigment										

6. Student workload – ECTS credits balance:

    1 ECTS credit corresponds to 25-30 hours of student work needed to achieve the expected learning outcomes including the student's own work

Activity (please specify relevant work for the subject)	Hourly student workload (full-time studies/part-time studies)
Participation in lectures	-
Participation in laboratory classes	45
Preparation to laboratory classes	45
Independent study of the subject	-
Preparation to a final test	10
Participation in an exam / graded assignment	2
Total student workload (TSW)	100
ECTS credits	4
* Student's workload related to practical forms	100
Student's workload in classes requiring direct participation of academic teachers	45

7. Implementation notes: recommended duration (semesters), recommended admission requirements, relations between the forms of classes:
    - Recommended admission requirements – none.
    - Recommended duration of the subject is taken from the course plan.
8. Specific learning outcomes – knowledge, skills and social competence:

| Specific learning outcomes for the subject | | Form | Teaching method | Methods for testing of (checking, assessing) learning outcomes |
Outcome symbol	Outcome description			
Knowledge				
K_W07	A student possesses sufficient knowledge in the field of technical informatics, including advanced issues concerning data transmission in automation systems and electronic devices, and to apply this knowledge in practice.	Laboratory work	Inquiry methods	Final test, Student learning activities
Skills				
K_U02	A student is able to use information and communication technologies (ICT) to create protocols, interfaces, and communication systems in the field of mechatronics.	Laboratory work	Inquiry methods	Final test, Student learning activities

9. Assessment rules / criteria for each form of education and individual grades:

Activity	Grades	Calculation	To final
Final test	bdb (5)	5 * 50%	2,50
Tasks done during laboratories	dst, db, bdb, db (3, 4, 5, 4)	arithmetic mean (3,4,5,4) * 50%	2,00
Final result			4,50

0 – 3.00	ndst	**4.01 – 4.50**	db
3.01 – 3.50	dst	**4.51 – 4.7**	db+
3.51 – 4.00	dst+	**4.71 – 5.0**	bdb

10. The learning contents with the form of the class activities on which they are carried out
(Laboratory work)

Introduction to communication system: communication systems, modulation, bandwidth requirement, channel capacity, baud rate, data rate, bit, bytes and characters, communication modes, synchronous and asynchronous system, error detection, error correction, transmission characteristics, data coding, UART and USART. Modulation: theory of amplitude modulation, frequency spectrum of AM wave, representation of AM, theory of frequency modulation, mathematical representation of FM, frequency spectrum of FM wave. theory of phase modulation, comparison of different modulations, digital modulation: modulation circuit, demodulation circuit, ASK, FSK, PSK, PWM, PAM, PP/M. Serial communication: balanced and unbalanced transmission lines, RS-232 interface, RS-422 interface, RS-485 interface, current loop, GPIB, USB interface, common serial communication problmes, design examples. Cabling: copper based cables, coaxial cables, twisted pair cables, fiber optic cabls, definition of noise, external and internal noise, noise calculation, frequency analysis of noise, source of electrical noise, electrical coupling of noise, shielding and grounding, noise suppression techniques, cable ducting, design examples. Industrial protocols: introduction to protocols, CAN, Fieldbus and DeviceNet system, modbus protocol, HART, industraial Ethernet - EtherCAT.

11. Required teaching aids:

   a. Lecture - multimedia projector

   b. Laboratory classes - specialist laboratory

12. Literature:
   a. Basic literature:

   1. Manuel Jiménez, Rogelio Palomera, Isidoro Couvertier; Introduction to Embedded Systems; ISBN 978-1-4614-3143-5; Springer, New York, NY 2014

   a. Number Systems and Data Formats - pages 31-80

   b. Fundamentals of Interfacing - pages 249-297

   c. Principles of Serial Communication - pages 475-536

   2. Frenzel, Louis E.; Handbook of Serial Communications Interfaces: A Comprehensive Compendium of Serial Digital Input/Output (I/O) Standards; ISBN 978-0-12-800629-0; Elsevier 2016

b. Supplementary literature:

    1. Warren Gay; Custom Raspberry Pi Interfaces; ISBN 978-1-4842-2406-9; Apress, Berkeley, CA 2017

    2. Jens-Rainer Ohm; Multimedia Signal Coding and Transmission; ISBN 978-3-662-46691-9; Springer, Berlin, Heidelberg 2015

c. Internet sources:

    1. Sparkfun Learning Tutorials - learn.sparkfun.com

    2. Industrial Wireless Guide - www.newark.com/wcsstore/ExtendedSitesCatalogAssetStore/cms/asset/pdf/americas/common/storefront/advantech/industrial-wireless-guide.pdf

    3. Industrial Ethernet Tutorial - www.automationworld.com/products/networks/news/13313765/industrial-ethernet-tutorial

    4. EtherCAT - www.ethercat.org/pdf/english/EtherCAT_Introduction_0905.pdf

    5. Full guide to serial communication protocol - www.maximintegrated.com/en/design/technical-documents/app-notes/3/3884.html

    6. Guide to selecting and using RS-232, RS-422 and RS-485 - www.maximintegrated.com/en/design/technical-documents/tutorials/7/723.html

    7. CAN tutorial - download.ni.com/pub/gdc/tut/can_tutorial.pdf

    8. HART Communication Tutorial - instrumentationtools.com/hart-communication-tutorial-part-1

    9. FieldBus tutorial - instrumentationtools.com/foundation-fieldbus-tutorials

    10. ZigBee tutorial - www.rfwireless-world.com/Tutorials/Zigbee_tutorial.html

13. Available educational materials divided into forms of class activities (Author's compilation of didactic materials, e-learning materials, etc.)

14. Teachers implementing particular forms of education:

Form of education	Name and surname
1. Lecture	
2. Laboratory classes	Buler Piotr, mgr
3. Training	
4. Project classes	
5. Workshop classes	
6. Simulation game	
7. Language classes	